THIRD FIVE-YEAR REVIEW REPORT

FOR

CHEM-DYNE SUPERFUND SITE

HAMILTON, OHIO

SEPTEMBER 2010

Prepared by

Ohio Environmental Protection Agency
Southwest District Office
Dayton, Ohio

And

United States Environmental Protection Agency
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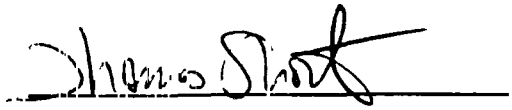
Approved by: **Date:**



9/23/2010

Richard C. Karl, Director
Superfund Division
U.S. EPA, Region 5

Chem-Dyne Site
Third Five-Year Review Report

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List of Acronyms and Abbreviations

ARARs	Applicable or Relevant and Appropriate Requirements
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CCL	Construction Completion List
EA	Endangerment Assessment
FS	Feasibility Study
IC	Institutional Controls
MCL	Maximum Contaminant Level
NCP	National Contingency Plan
NPDES	National Pollution Discharge Elimination System
NPL	National Priorities List
OAC	Ohio Administrative Code
PRPs	Potentially Responsible Parties
RAP	Remedial Action Plan
RAOs	Remedial Action Objectives
RI	Remedial Investigation
RCRA	Resource Conservation and Recovery Act
Site	The Chem-Dyne Site
SVE	Soil Vapor Extraction
Trust	The Chem-Dyne Trust
VOC	Volatile Organic Compound

Executive Summary

This five-year review of the Chem-Dyne Site covers the period from the date of the last five-year review, September 27, 2005, to the September 2010 date of signing. The 2010 five-year review concludes that the remedy components of the Record of Decision (ROD) continue to function within the compliance criteria established by the Consent Decree. The remedy also operates in compliance with applicable or relevant and appropriate requirements and provides protection of human health and the environment. Hydraulic containment of volatile organic compounds (VOCs) above the ground water performance goal of 100 ug/L continues to be demonstrated at the Site.

Following the Agency's recommendation in the last five-year review (Sept 2005), the Trust took action to delineate the residual source and augment the ground water pump and treat system. Beginning in October 2007, the Trust delineated VOCs in soil gas and ground water in the northern portion of the Site, and in the immediately adjacent, and down-gradient Hamilton Power Plant property to the west. Results revealed the presence of significant VOC mass in ground water and soil gas. Soil gas concentrations beneath the cap were orders of magnitude higher than offsite areas, indicating an on-site source. Based on the resulting data, the Trust installed and initiated a soil vapor extraction system (SVE) in the northern portion of the Site. The SVE system was successful in removing 955 lbs from the unsaturated zone, between the November 11, 2008 start-up and March 31, 2009. Following the performance record of the northern SVE system, the Trust expanded its site characterization efforts, and subsequently initiated two more SVE systems in the southern portion of the Site in late September 2009. Between system start up and February 24, 2010, the two southern systems have removed a total 165.32 lbs. The combined mass removal from all three SVE systems for year 2009 was 1,361 lbs, compared to the mass removal of 103 lbs from the ground water pump and treat system. The SVE mass removal for 2009 exceeded the pump and treat mass removal from the five previous years combined. As of January 12, 2010 the cumulative SVE mass removal since start-up has been 1,885 lbs. Currently, SVE mass removal rates are declining, approaching 1 lb per day. Although substantially declined, SVE annual mass removal in 2010 is anticipated to exceed that from pump and treat.

Although SVE has removed substantial vapor phase VOC mass from the unsaturated zone, current trends do not yet suggest an expedited attainment of ground water performance goals, which is desired, as the costs of operating and maintaining the aging ground water pump and treat system are increasing. As of March 2009, eight of the Site's 68 wells within the limits of the current plume boundary were above the 100 ug/L performance goal. With pump and treat being primarily effective for maintaining hydraulic containment, the Agency recommends further delineation of source areas potentially

slowing attainment of ground water performance goals, followed by an in-situ treatment evaluation. Otherwise, attainment of ground water performance goals will not be expedited.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name *(from WasteLAN)*: Chem-Dyne		
EPA ID *(from WasteLAN)*: OHD074727793		
Region: 5	**State:** Ohio	**City/County:** Hamilton / Butler
SITE STATUS		
NPL status: X Final G Deleted G Other (specify)		
Remediation status (choose all that apply): G Under Construction X Operating G Complete		
Multiple OUs? ☐ YES X NO	**Construction completion date:** 09/11/1992	
Has site been put into reuse? ☐ YES X NO		
REVIEW STATUS		
Lead agency: X EPA X State ☐ Tribe ☐ Other Federal Agency		
Author name: Matt Justice, Ohio EPA; and Lolita Hill, U.S. EPA		
Authors title: Site Coordinator and RPM respectively	**Authors affiliation:** Ohio EPA and U.S. EPA respectively	
Review period: 09/27/2005 to Signature Date of this five-year review		
Date(s) of site inspection in 2009: Jan 7, 8, 9, 12, 14; Feb 9, 10; May 18; June 18; July 20, and August 5		
Type of review: ☐ Post-SARA X Pre-SARA ☐ Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead ☐ Regional Discretion		
Review number: ☐ 1 (first) ☐ 2 (second) X 3 (third) ☐ Other (specify)		
Triggering action: ☐ Actual RA Onsite Construction at OU # ☐ Actual RA Start at OU#____ ☐ Construction Completion X Previous Five-Year Review Report ☐ Other (specify)		
Triggering action date *(from WasteLAN)*: September 27, 2005		
Due date *(five years after triggering action date)*: September 27, 2010		

Issues:

As of March 2009, eight of the Site's 68 wells within the limits of the current plume boundary were above the 100 ug/L total VOC performance goal. Among these, the most elevated well is consistently shallow monitoring well MW-15, located down-gradient of the Chem-Dyne Site at the Hamilton Power Plant. In the face of numerous engineering and logistical challenges, the source areas affecting ground water quality at MW-15 and other wells have not yet been delineated. With pump and treat now primarily effective for maintaining hydraulic containment, and with SVE mass removal rates beginning to decline, an expedited attainment of ground water performance goals for MW-15 and additional wells is not yet anticipated. If attainment of performance goals is not significantly expedited, operational and maintenance costs associated with the aging pump and treat system will continue to increase.

Recommendations and Follow-up Actions:

1. In order to expedite attainment of ground water performance goals established by the Consent Decree, the Agency recommends a phased approach for ground water plume delineation. First, we recommend vertical aquifer sampling during the spring water table high to further delineate the nature and extent of the northern and southern ground water plumes. This phase would be followed by monitoring well design and installation. The purpose of new monitoring wells is to fill current plume delineation data gaps, and to measure improvements in ground water quality with time. Delineation of the northern plume is the highest priority to address intermediate extraction wells IE-1 and IE-8, and shallow monitoring well MW-15. The resulting data should be interpreted to produce concentration contour maps and cross-sections for the dominant compounds present in addition to total VOCs. Completion of this phase should enable a general identification of the upgradient source area which is currently prohibiting attainment of ground water performance goals.

2. After plume delineation, the Agency recommends that the Trust further delineate the extent of source areas influencing ground water quality. A dense distribution of samples may prove needed in the northwestern portion of the Site, in particular the footprint of the former Chem-Dyne building, and the former tank farm area immediately west along the CSX owned rail road. The resulting data will allow the Trust to evaluate alternative remedies for treating the source and expediting attainment of ground water performance goals.

3. Finally, in order to ensure long-term protectiveness, the Trust must evaluate the institutional controls that are in place and that might otherwise be necessary.

Protectiveness Statement(s):

The site remedy currently protects human health and the environment because the excavation and removal of contaminated soils, the ground water monitoring and extraction system, and the site cap with impermeable infiltration barrier are functioning as designed and are protective of human health and the environment in the short-term. Once all ground water remedial action cleanup goals are achieved and the institutional controls fully implemented, the remedy should provide long-term protection.

I. Introduction

The objective of the five-year review report is to evaluate the protectiveness of the remedy, identify issues of concern, and provide recommendations to address those issues. Ohio EPA and U.S. EPA prepared this five-year review pursuant to Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) §121 which states: *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

Ohio EPA and U.S. EPA also prepared this five-year review pursuant to The National Contingency Plan (NCP); 40 CFR § 300.430(f)(4)(ii) which states: *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

This policy five-year review was triggered by the date the site qualified for listing on the Construction Completion List (CCL). Chem-Dyne qualified for the CCL on the date of signature for the final Close Out Report. The interim Close Out Report was completed September 11, 1992. The first policy five-year review was approved on September 8, 2000. This is the third five year review for the Site. The triggering action for this review is the date of the last report, September 27, 2005. The review spans the period September 2005, through September 2010.

II. Site Chronology

Table 1. Site Chronology

Date	Event
Late 1950's	Ford Motor Company ceased operation of tractor factory at the Site location
1974-1979	Site was used for the processing and storage of chemical wastes
September 8, 1983	Site finalized for NPL
May 22, 1984	Remedial Investigation completed
November 19, 1984	Feasibility Study completed
July 5 1985	Remedial alternative selection in the enforcement decision document signed
October 9, 1985	Consent Decree lodged between U.S. EPA, Ohio EPA, and PRPs
January 1, 1988	Operational ground water extraction system approved
1992	Ground water re-injection operations terminated
November 1998	Ohio EPA issued permit discontinuing air monitoring requirement
September 8, 2000	First five-year review approved
October 4, 2004	13 ground water extraction wells shut down as part of two year flow model validation
September 27, 2005	Approval of second five-year review
October 2007	VOC Residuals Investigation, northern site and Hamilton Power Plant property
November 2008	Northern soil vapor extraction system (SVE) start-up
September 2009	Southern SVE system start-up
November 2009 and March 2010	Ohio EPA and U.S. EPA approval of NPDES permit modification proposal to discontinue air stripper treatment of pump and treat extracted ground water

III. Background

A. Location

The Chem-Dyne Site is located at 500 Joe Nuxhall Boulevard, Hamilton, Ohio 45011. The 21 acre site is bound by the Ford Hydraulic Canal to the north, residentia areas and athletic fields to the south, athletic fields to the east, and industrial areas to the west. The Site is located approximately 1,000 feet east of the Great Miami River (Figure 1).

B. Hydrogeology and Ground Water Use

Topography in the Site vicinity is relatively flat. Average depth to water is approximately 25 feet below ground surface. Ground water flow beneath the Site is westerly toward the Great Miami River. The Remedial Investigation completed in 1984 concluded that ground water flow velocities ranged from 0.5 to 1.5 feet per day. Ground water flow is heavily influenced by the stage of the Great Miami River, and localized pumping. The geology of the Hamilton, Ohio area is dominated by glacial valley fill deposits that overlie bedrock of Ordovician age limestone and shale. In the Hamilton area, glacial deposits are thickest where they fill the bedrock valleys of the ancient Teays River System. The modern-day Great Miami River follows these valleys for much of its course, including the vicinity of Hamilton (Papadopulos and Associates, 2003). Deposits filling the valleys are approximately 150 to 200 feet thick (Watkins and Spieker, 1971). Most of these deposits are coarse grained sands and gravels saturated with water. The saturated deposits constitute a prolific aquifer known as the Miami Valley Sole Source Aquifer System. The sole source aquifer designation is a federal designation used to protect drinking water supplies in areas with few or no alternative sources of drinking water. The sole source aquifer designation protects an area's ground water resources by requiring U.S. Environmental Protection Agency review of any proposed projects within the designated area that are receiving federal financial assistance.

The most significant active pumping centers near the Site are the Hamilton North well field, pumping at an average rate of 2 million gallons per day (mgd), and the Hamilton Power Plant immediately adjacent to and west of the Site. The Hamilton Power Plant operates two production wells for cooling water, HP-8 and HP-9. According to a 2008 Ohio EPA interview of the plant operator, Mr. Dan Moats, the plant relies primarily on well HP-8. Based on average monthly withdrawal volumes for year 2006, Ohio EPA calculated an average annual withdrawal rate of 479 gallons per minute (gpm) for HP-8 and 139 gpm for HP-9. This calculation is consistent with that reported by Papadopulous & Associates (2003) as being 0.8 mgd or 555 gpm since year 2000.

C. *History of Site Use*

Ford Motor Company operated a tractor factory at the Site which ceased operations in the late 1950s. Later, between 1974 and 1979, the Chem-Dyne Corporation used the Site for the processing and storage of chemical wastes. During this time, the Site accepted an estimated 112,000 drums of waste from approximately 200 generators. Materials handled included pesticides, chlorinated and un-chlorinated solvents, waste oils, plastics and resins, PCBs, acids and caustics, metal and cyanide sludges, and laboratory wastes. Over 30,000 drums and 300,000 gallons of bulk materials were on-site when operations ended in 1980.

D. *Initial Response*

Most of the materials left on the Site were removed under the supervision of a state court appointed receiver between 1980 and 1981. Subsequent waste removal actions began in 1982. The remaining wastes were removed during a surface clean-up under U.S. EPA removal authority in 1983. The Site was proposed for inclusion on the National Priorities List on October 21, 1981, and finalized on September 8, 1983.

E. *Basis for Taking Action*

The Remedial Investigation (RI), completed May 22, 1984, identified elevated VOC soil concentrations on-site. The highest VOC concentrations were located 3 to 6 feet below ground surface (bgs), extending as deep as 25 feet bgs. The Feasibility Study (FS), released on November 19, 1984 contained an Endangerment Assessment (EA) concluding that direct contact with soils presented an unacceptable risk.

The RI also defined an expansive ground water VOC plume, emanating from the site, and extending onto adjacent properties. In 1986, the total VOC plume was delineated to be approximately 1,000 feet wide, 1,800 feet long, and up to 50 feet deep. The EA concluded that ground water presented an unacceptable risk for potable use. It also concluded that continued migration of the ground water plume could present an unacceptable risk to down-gradient water supplies.

IV. Remedial Actions

A. *Remedy Selection*

Following negotiations with the potentially responsible parties (PRPs), a Remedial Action Plan (RAP) was developed for the Site. The RAP, dated May 1985 was incorporated into a judicial consent decree lodged in U.S. District Court, for the Southeastern District of Ohio, Western Division, on October 9, 1985. The selected remedy for the Site required the demolition of all Site buildings, the removal of a hot spot soil, the installation of a cap over remaining contaminated soils, and the installation of a ground water extraction-injection system. The Consent Decree is

administered jointly by U.S. EPA and Ohio EPA. It was signed by 173 PRPs. The PRPs formed the Chem-Dyne Site Trust Fund (Trust), to manage and fund required actions.

B. Remedy Implementation

The major components of the remedial action for the Chem Dyne Site included the demolition of all Site buildings and excavation of "hot spot" soil, the installation of a ground water pump and treat extraction system, and the installation of a cap with infiltration barrier layer.

Soil hot spots were removed and disposed at an approved off-site facility in an expedited action in the spring of 1985. A total of 8 buildings were demolished, with foundations and basements being left in place. A perimeter utility cutoff trench approximately 4,000 feet in length and 15 feet deep was excavated around the Site and all intercepted utilities were sealed. A storm sewer system for draining the capped Site was also installed.

Monitoring wells were installed to further define the boundaries of the migrating ground water plume. Ground water remediation activities began in February 1987 with completion of a ground water extraction-injection system. A total of 25 extraction wells and 8 injection wells were installed. After several modifications, the Trust proposed that the ground water extraction system be considered fully operational on January 1, 1988. Thus January 1, 2010 marks the twenty-second year of operations since the proposal. Re-injection operations were terminated in 1992.

Until an April 12, 2010 NPDES permit modification approval, an air stripper system operated for ex-situ ground water treatment. The air stripper system remains connected to extraction wells by 10,000 feet of subsurface piping. Off-gas from the air stripper was directed to three activated carbon beds for treatment. Treated water was either injected into the aquifer in order to flush VOCs from subsurface soils, or discharged to the Ford Hydraulic Canal in accordance an NPDES permit issued by Ohio EPA.

C. System Operations

Remedial system operations were reviewed for compliance with federal and state law, per Section IV, paragraph C1 of the Consent Decree which states that *all activities undertaken...pursuant to this Consent Decree shall be undertaken in accordance with the requirements of all applicable local, state and federal laws, regulations and permits.* The Consent Decree describes the environmental laws applying to the site as the Resource Conservation and Recovery Act (RCRA), the Clean Water Act, the Clean Air Act, the Safe Drinking Water Act, and the Toxic Substances Control Act (TSCA).

1. **Safe Drinking Water Act**

Ground water sampling results indicate that no VOCs, semi-volatile organic compounds, or metals exceeded the drinking water MCL in 2009, in any consent decree established compliance monitoring or production well. Compliance criteria were originally established for four local production wells. Of these, only the Hamilton Power Plant remains in operation. No VOCs were detected at the power plant during the span of this five-year review.

The consent decree establishes MCLs as the compliance criteria for offsite western compliance monitoring wells, and a 10^{-6} risk criteria or background value, whichever is greater, for offsite southern compliance monitoring wells, based on the RI results reported in 1984. The RI determined that ground water south and southwest of the Site had not been affected by the Site, at that time. Subsequent data from compliance monitoring began showing VOCs in the southern wells in 1989. In 1990, the agencies required the Trust to investigate. The Trust concluded that the source of VOCs was a plume of unknown origin. The Trust also made the following recommendations: 1) continue monitoring the southern compliance wells with the understanding that samples from these wells are not indicative of ground water migrating from the Site; 2) apply compliance criteria specified in the Consent Decree for the southern compliance wells after the termination of the extraction system; and 3) reassess conditions in the vicinity of the southern compliance wells after at least a year of water level and water quality data collection. The agencies concurred with the Trust=s recommendations (Five-Year Review, September 2000).

The last compliance monitoring wells to exceed compliance criteria were southern compliance monitoring well G-21, with TCE at 9.8 ug/L in March 2008, and southern compliance monitoring well MW-17, with TCE at 10.72 ug/L in September 2007. As stated above, the detections in both wells may be due to an alternate source, other than the Chem-Dyne Site. Both monitoring well MW-17 and G-21are located on property used as a salvage/junk yard. Monitoring well MW-17 is located down-gradient of the now vacant Niles Tool Works, and the Champion Paper Company. These properties recently underwent an Ohio Voluntary Action Program Phase II property assessment, which reported that no VOCs were emanating from the upgradient Chem-Dyne parcel. Ohio EPA recently approved a pump and treat remedial action plan for this near-by property. Activation of the pump and treat system is scheduled for October 2010.

2. **Clean Water Act**

On October 2, 2009, the Trust applied for a NPDES permit modification to discontinue treating the ground water extracted from the pump and treat system via the air stripper, and discharge it directly to the canal. The Ohio EPA Division of Surface water approved this modification on November 25, 2009. As noted in Ohio EPA's approval letter, the ground water influent to the air stripper had been in

compliance with both the daily maximum and monthly average permit limitations since November 2008. The Trust agreed to properly maintain the air stripper for future treatment if compliance sampling indicates treatment is warranted. U.S EPA granted approval of this modification in March 2010, and the stripper was subsequently deactivated on April 12, 2010.

3. **Resource Conservation and Recovery Act**

Ohio EPA last conducted a RCRA compliance evaluation on June 7, 2005. The Site was determined to be in compliance with the terms of a RCRA permit to operate as a generator of RCRA regulated off-Site shipments of waste produced from the air stripper. With the air stripper now deactivated as of April 12, 2010, the system no longer generates hazardous waste.

4. **Clean Air Act**

In November 1998, Ohio EPA issued a letter to the Trust indicating that emissions from the air stripper were of an amount and type to be considered minimal, thereby discontinuing air monitoring of the air stripper effluent.

In May, 2010, Ohio EPA and U.S. EPA approved the Trust's proposal to deactivate the SVE influent carbon treatment vessels. As SVE data indicates, air emissions have never exceeded the 10 lbs/day deminimis limit. Declining VOC mass removal trends continue for the northern SVE system and both the A and B southern SVE systems.

D. Institutional Controls

Institutional controls (ICs) are non-engineered instruments, such as administrative and/or legal controls, that help minimize the potential for exposure to contamination and protect the integrity of the remedy. Compliance with ICs is required to assure long-term protectiveness for any areas which do not allow for unlimited use or unrestricted exposure (UU/UE).

No decision document requiring ICs exists for the site. However the Consent Decree lodged in 1985 requires institutional controls in the form of ground water use restrictions in Section VII, Paragraph E. Section VII, Paragraph E of the Decree states that the State agrees to use its statutory and regulatory authority to prohibit the installation of wells into contaminated ground water at or near the Chem-Dyne Site, with the area marked on Appendix 5 of the Consent Decree, or as it may be enlarged or reduced by Ohio EPA following consultation with U.S. EPA. This requirement is consistent with Ohio Administrative Code (OAC) 3745-9-04, which regulates the location of new wells and does not allow installation of wells in areas which may become contaminated.

In order to ensure long-term protectiveness, additional institutional controls should be evaluated for the area contained by the site boundary (Figure 1). The Site currently does not support unlimited potable ground water use and unrestricted exposure. Page 23 of the last five-year review, dated September 27, 2005, states that U.S. EPA will evaluate institutional controls "such as deed restrictions, covenants, and easements...to assist in providing long-term environmental stewardship." Any restrictive covenant should be in accordance with the State of Ohio Uniform Environmental Covenants Act. Given that some chemical compounds in the ground water beneath the site will probably remain elevated above the 100 ug/L performance goal at the conclusion of remedial actions, EPA will encourage the Trust to work with the City to establish a local ordinance to restrict the use of the aquifer beneath the Site.

Table 2. Institutional Controls Summary Table

Media, Engineered Controls, & Areas that Do Not Support UU/UE Based on Current Conditions.	IC Objective	Title of Institutional Control Instrument Implemented (note if planned)
Chem-Dyne site boundary groundwater	Prohibit use of groundwater at Site	None except Ohio Administrative Code; UECA Covenant (planned)
Chem-Dyne site	Prohibit residential use and prevent damage to remedy components	None UECA Covenant (planned)

V. Progress Since the Last Five-Year Review

The protectiveness statement of the last five-year review stated that the remedy was protective and that the ground water extraction system was providing hydraulic containment. In addition, the five-year review recommended delineating residual source areas and then aggressively treating those areas to achieve ground water cleanup criteria stipulated by the terms of the Consent Decree. Since then, the Trust has undertaken significant action to treat on-site soil vapor which was potentially affecting ground water performance goals.

A. IE-1 Shutdown Proposal

Shortly after the five-year review in 2005, the agencies received a proposal from the Trust to conduct an experimental six month shutdown of intermediate depth, offsite extraction well IE-1, followed by permanent shutdown contingent upon a predicted VOC concentration decline (memorandum, S.S. Papadopulos & Associates, Inc., Nov. 21, 2005). This proposal was significant because approximately half of the

total VOC mass removed from ground water is typically extracted from extraction well IE-1.

The proposal hypothesized that elevated VOC concentrations in the intermediate depth well were attributable to drag-down of a shallow plume by intermediate depth pumping. In evaluating the hypothesis, questions emerged as to why VOC concentrations are more elevated in intermediate depth well IE-1 than the overlying shallow extraction well SE-3. After several work plan iterations, the Trust withdrew the proposal on April 27, 2006 (Ohio EPA interoffice communication, April 28, 2006). Alternative explanations proposed for the predicted concentration decline following well shut-down were proposed as follows: 1) inability to intercept upgradient, elevated intermediate depth ground water; or 2) inability to intercept both elevated, upgradient shallow and intermediate depth ground water.

B. Residual Source Investigation, October 2007

Soon after withdrawing the IE-1 shutdown proposal, the Trust took significant action to delineate the residual source and augment the ground water pump and treat system. In May 2007, the Trust placed the fate and transport modeling effort on hold, pending improved delineation of residual source, and then began investigating potential source areas. Beginning in October 2007, the Trust conducted vertical aquifer sampling and soil gas sampling in the northern portion of the Site, and the immediately adjacent, down-gradient Hamilton Power Plant property to the west. Soil gas concentrations beneath the site cap were orders of magnitude higher than off-site soil gas concentrations, indicating the presence of on-site source. The on-site vertical aquifer sample location with the highest ground water concentrations was VP-3, located approximately 50 feet northeast of the Ransohoff building. Shallow ground water at VP-3 was non-detect, while intermediate depth ground water contained elevated concentrations of primarily ethylbenzene and xylene compounds. These compounds are either absent or present in minor concentrations at shallow monitoring well MW-15 and intermediate depth extraction wells IE-1 and IE-8. Chlorinated solvents were dominant in intermediate depth on-site ground water north of VP-3, at locations VP-1 and VP-2. These sample locations have the same distribution of chlorinated VOCs as down-gradient monitoring well MW-15 and extraction wells IE-1 and IE-8.

C. Soil Vapor Extraction

Following the October 2007 residual source investigation, the Trust installed and initiated a soil vapor extraction system (SVE) in the northern portion of the Site in November 2008. The SVE system was successful in removing 955 lbs of VOCs from the unsaturated zone, between the November 11, 2008 start-up and March 31, 2009. Following the performance record of the northern SVE system, the Trust expanded its site characterization efforts, and subsequently initiated two more SVE systems in the southern portion of the site in late September 2009. Between system start up and February 24, 2010, the two southern systems have removed a

total 165.32 lbs of VOCs. The combined mass removal from all three SVE systems for year 2009 was 1,361 lbs, compared to mass removal of 103 lbs of VOCs from the ground water pump and treat system (Figure 2). The SVE mass removal for 2009 exceeded the pump and treat mass removal from the five previous years combined. As of January 12, 2010 the cumulative SVE mass removal since start-up has been 1,885 lbs. Currently, SVE mass removal rates are declining, approaching 1 lb per day. Although substantially declined, SVE annual mass removal in 2010 is anticipated to exceed that from pump and treat.

Table 3. Actions Taken, Sept 2005 through Sept 2010

Nov 2005	Chem-Dyne Trust proposal for six month experimental shutdown of intermediate depth, offsite extraction well IE-1, followed by permanent shutdown contingent upon a predicted VOC concentration decline (memorandum, S.S. Papadopulos & Associates, Inc., Nov. 21, 2005)
Apr 2006	Chem-Dyne Trust withdraws proposal for experimental shutdown of intermediate depth, offsite extraction well IE-1(April 27, 2006 conference call between Ohio EPA, U.S. EPA, and the Trust, see Ohio EPA interoffice communication, April 28, 2006)
Nov 2006	Written agreement from the Trust to evaluate and document ground water containment in future annual reports, based on contour maps of maximum and minimum water level elevations, rather than average annual values as previously reported (letters from Trust to Ohio EPA and U.S. EPA, Nov. 8, 2006).
Nov 2006 thru Dec 2006, and Feb 2007	Step Testing and Rehabilitation of extraction wells: SE-3, SE-6, SE-7, SE-8, SE-10, SE-11, SE-14, and IE-1 (Feb 2007)
May 2007	Trust suspends contaminant fate and transport model development and calibration efforts
Oct 2007	VOC Residuals Investigation, northern site and Hamilton Power Plant property
Nov 2008	Northern soil vapor extraction system (SVE) start-up
Nov 2008 thru Mar 2009	Northern SVE system: removes 955 lbs. of VOCs between Nov. 2008 start-up and March 2009
Jan 2009	Northern plume well installation: extraction well IE-8 and six monitoring wells, MW-37 thru MW-42
Jan 2009	Southern plume: install monitoring in replacement of extraction well SE-13
Jul – Sep 2009	Southern plume: installation of SVE systems A and B
Fall 2009	Southern SVE system start-up
Nov 2009 and Mar 2010	Ohio EPA and U.S. EPA approval of NPDES permit modification to discontinue air stripper treatment of pump and treat extracted ground water

VI. Five Year Review Process

A. Community Involvement

A public notice announcing the start of the five-year review was placed in the *Hamilton Journal News* on June 21, 2010. No public comments were received.

Notice of the completed five-year review will be placed in the *Hamilton Journal News* and the Third Five Year Review Report will be available at the information repository. The information repository is located at the Site, located at 500 Joe Nuxhall Boulevard in Hamilton, Ohio.

B. Document Review

This five-year review consisted of a review of O&M records, monthly reports, relevant documents, and the following documents submitted by the Trust since the last five-year review:

1. Chem-Dyne Site Proposal for the Experimental Shutdown of Intermediate Extraction Well IE-01, S.S. Papadopulos & Associates, Inc., Nov. 21, 2005
2. Chem-Dyne Site Modified Proposal for the Experimental Shutdown of Intermediate Extraction Well IE-01, S.S. Papadopulos & Associates, Inc., Feb. 1, 2006
3. Suspension of Groundwater Model Evaluation at the Chem-Dyne Superfund Site, Hull & Associates, May 16, 2006
4. 2005 Annual Report, S.S. Papadopulos & Associates, Inc., July 2006
5. Responses to Ohio EPA Comments, Chem-Dyne Site, 2005, letter, Ken Dupuis (Trustee), November 8, 2006
6. Responses to Ohio EPA Comments-Supplemental, Chem-Dyne Site, 2005, letter, Ken Dupuis (Trustee), December 21, 2006
7. Extraction Well Rehabilitation; Chem-Dyne Site, Hull & Associates, May 16, 2007
8. 2006 Annual Report, S.S. Papadopulos & Associates, Inc., May 18, 2007
9. Work Plan for Field Sampling in Support of VOC Residuals Investigation, Chem-Dyne Site, Hull & Associates, June 2007
10. Response to Ohio EPA Comments, Chem-Dyne Site, Work Plan for Field Sampling in Support of VOC Residuals Investigation, June 2007, Chem-Dyne Site, Hull & Associates, August 21, 2007
11. Response to U.S. EPA Comments, Chem-Dyne Site, Work Plan for Field Sampling in Support of VOC Residuals Investigation, June 2007, Chem-Dyne Site, Hull & Associates, September 7, 2007

12. Addendum to the Work Plan for Field Sampling in Support of VOC Residuals Investigation, June 2007; Chem-Dyne Site, Hull & Associates, October 3, 2007

13. VOC Residuals Investigation Summary Report for the Chem-Dyne Superfund Site, Hull & Associates, February 2008

14. 2007 Annual Report, Hull & Associates, Inc., May 2008

15. Long Term Monitoring and Optimization Plan for the Chem-Dyne Superfund Site, Hull & Associates, October 2008

16. HDPE Liner Integrity – Summary of the Seventh Coupon Destructive Test Results, Chem-Dyne Superfund Site, Hull & Associates, November 3, 2008

17. Replacement of Shallow Extraction Well SE-13, Chem-Dyne Superfund Site, Hamilton, Ohio, Hull & Associates, December 22, 2008

18. Finalization of Long Term Monitoring and Optimization Plan, Chem-Dyne Superfund Site, Hull & Associates, April 27, 2009

19. Letter Work Plan for Supplemental Geologic Investigation and Soil Vapor Extraction Installation, South Plume, Chem-Dyne, Hull & Associates, May 26, 2009

20. 2008 Annual Report, Hull & Associates, Inc., June 2009

21. Summary of North Plume Extraction and Monitoring Well Installation, Chem-Dyne Superfund Site, Hamilton County, Ohio, memorandum, Hull & Associates, June 12, 2009

22. Request to Terminate Groundwater Treatment and Discharge Directly into the Ford Hydraulic Canal, Chem-Dyne, letter, Hull & Associates, Oct 2, 2009

23. Southern Plume Subsurface Investigation Concurrent with the SVE System Installation, Chem-Dyne Superfund Site, Hull & Associates, October 27, 2009

24. Response to Additional Information Request, Butler County, Chem-Dyne Air Stripper, NPDES Permit #OH0092657; Ohio EPA Permit No. 1IN00100*ES, Hull & Associates, letter, Nov. 23, 2009

25. SVE Expansion Summary Report, Progressive, Nov. 16, 2009

26. 2009 Annual Report, Hull & Associates, Inc., May 2010

27. Request to Terminate Daily Water Level Monitoring from P-1 through P-6 at the Chem-Dyne Superfund Site, Hamilton, Ohio, letter, Hull & Associates, April 27, 2010.

C. Data Review

In order to meet the objectives of the Remedial Action Plan, the Chem-Dyne Trust maintains a remedy with three main components. These components are: 1) a site cap; 2) institutional controls; and 3) a ground water extraction system. Data relating to the performance of the remedy were reviewed as follows:

1. Site Cap

The remedy calls for a multi-layer cap installed over the residual contaminated soil. The cap consists of 6 inches of topsoil overlying 6 inches of loam. This upper zone overlies 16 inches of sand. The sand overlies two feet of low permeability clay. A liner consisting of high density polyethylene is in place at a depth of 22 inches below ground surface. The remedial objectives of the cap are to limit direct contact exposure and reduce mass loading to ground water. Section V, Paragraph 8.4 (c) of the Consent Decree describes the programs for monitoring performance. Originally neutron probes were used. In 1999 the agencies agreed to the Trust's request to discontinue the use of neutron probes. The programs remaining for evaluating the site cover are: 1) quarterly visual inspection of the cap for slumping and erosion; and 2) destructive testing of coupon samples representative of the synthetic liner every third year.

A letter report dated November 3, 2008 by Hull & Associates summarizes the most recent destructive coupon test results from April 2008. Eight high-density polyethylene liner coupons were installed in 1986 proximate to and under the same conditions as the Site cover upon construction of the cap. As required by the Consent Decree, every third year one coupon is removed and destructively tested to evaluate long term liner performance. April 2008 marks testing of the seventh of the eight installed coupons. Ohio EPA evaluation of the report concluded that the integrity of the cap is declining with time, but is meeting remedial objectives.

2. Ground Water Extraction System

The Consent Decree requires operation of a ground water extraction system, designed to reduce the 1986 ground water plume to stated levels and hydraulically contain the plume. Subparagraph 2.05 defines the 1986 plume extent by the 100 ug/L total priority pollutant volatile organic compound contour. The system is designed to maintain an inward hydraulic gradient, both vertically and horizontally, and to ensure that contaminants within the 1986 plume boundary are contained for removal and treatment. Head level measurements reported on a quarterly basis together with analytical ground water results indicate that the ground water

extraction system is operating in compliance with the terms of the Consent Decree. Hydraulic containment of the plume was demonstrated each year covered by the span of this five year review.

D. Site Inspection

The following site inspections were carried out by Matt Justice, site coordinator with Ohio EPA in 2009.

Table 4. Ohio EPA Site Inspection Dates, 2009

Date	Action
January 7	Observe extraction well IE-8 boring
January 8	Observe monitoring well MW-37 boring
January 9	Observe monitoring well MW-40 I boring
January 12	Observe monitoring well MW-39 boring
January 14	Observe monitoring well MW-42 (SE-13R) boring
February 9 and 10	Deploy pressure transducers in monitoring wells and install temperature buttons on Hamilton Power Plant extraction wells with U.S. EPA
May 13	Remove pressure transducers from monitoring wells and install temperature buttons on Hamilton Power Plant extraction wells with U.S. EPA
July 20	Observe installation of SVE-24 and SVE-30
August 5	Meeting with Chem-Dyne trustee Mike Tischuk. Inspect soil vapor extraction system

E. Interviews

Community Interviews were not conducted as part of this five-year review. However the agencies responded to requests for Site progress updates from Mr. Tim McLelland of the Hamilton to New Baltimore Consortium on several occasions. Mr. Ron Holt, the site operations manager, was interviewed on several occasions concerning ground water pump and treat, air stripper, and SVE performance. The Trust's primary consultant, Ms. Tracy Edwards, project manager with Hull & Associates, Inc., was interviewed multiple times during the span of this five year review. Mr. Gregory Rorech, engineer with Progressive Engineering & Construction, Inc. was interviewed on several occasions over the past two years concerning design, installation, and performance of the SVE system.

VII. Technical Assessment

Question A: Is the remedy functioning as intended?
The remedy is operating in compliance with the ARARs. The ground water extraction system is providing hydraulic containment. However results also indicate that ground water performance goals will be difficult to achieve in a timely and cost-effective manner.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection still valid?

The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives are still valid. Section V, subparagraph 2.7 of the Consent Decree establishes two "performance goals" as follows: 1) attainment of 100 ug/L total priority pollutant VOCs and, 2) concentrations becoming "effectively constant." According to subparagraph 2.9, if after the twentieth year of operations these two performance goals have not been met "the Plaintiffs and the Settling Defendants shall determine whether further operation and modification would be cost effective." Although the system has been operational more than 20 years, subparagraph 2.10 requires that ground water concentrations not rebound after system shutdown for a period of five years. Should the system be terminated in the current state of operation, rebound above termination concentrations is expected soon thereafter. Therefore, termination of the pump and treat system has not been proposed, even though it has been active longer than twenty years.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No new information has come to light which could call into question the protectiveness of the remedy.

VIII. Issues

A. The ground water pump and treat system was initially very successful in removing significant dissolved phase mass. But a decline in mass removal efficiency over the past ten years indicates that the system no longer provides the treatment necessary for attaining ground water performance goals in a time efficient manner. The cumulative VOC mass removed by the pump and treat system since start-up in February 1987 through the end of 2009 was 34,916 lbs. Seventy-seven percent of this mass (27,054 lbs) was removed during the first six years of operation. During the previous three years (2006 through 2009) the system removed only 2% (834 lbs) of the cumulative mass. Mass removal is still significant, but has steadily declined with time. Because the bulk of remaining source mass is probably bound to low permeability on-site soils in the unsaturated zone and the aquifer matrix, rather than being distributed in the dissolved phase, future ground water extraction will prove effective primarily for hydraulic containment.

B. Northern plume delineation, as reported in the 2009 Annual Report, is currently jeopardized by an absence of shallow monitoring wells in the northern portion of the Site. Vertical aquifer sampling results from October 2007 indicate that the 2009 Annual Report interpretation is incomplete. The October 2007 residual source investigation identified a northern plume emanating from the Site through vertical aquifer sampling. Onsite vertical aquifer sample locations VP-1 and VP-2 which detected elevated chlorinated hydrocarbons, were sampled in an area of the Site formerly absent of monitoring wells. Potential source areas north of VP-1 and VP-2, within the footprint of the former Chem-Dyne building, and the former tank farm immediately west of the Site, are also absent of monitoring wells. In the absence of shallow monitoring well data, the 2009 Annual Report, figures 10, 12, 14, and 16, depicts the shallow plume as being isolated off-site at the power plant with no on-site plume.

C. Significant challenges to drilling and well installation in support of plume and source delineation include subsurface heterogeneity, buried utilities, and drilling refusal in on-site areas where concrete building foundations and basements were buried in-place under the cap as part of approved removal actions. Subsurface building structures have made recent characterization attempts difficult. For example in January 2009, drilling within the footprint of the former Ford Motor plant building encountered approximately eight continuous feet of solid concrete, to a depth of 15 feet bgs at MWI-41 (Figure 3).

If plume and source delineation in support of attaining performance goals is not undertaken, operational and maintenance costs associated with the aging pump and treat system are expected to out-pace investigative costs. From September 23, 1985 to December 31, 2009, the settling defendants have spent $35,028,388 to maintain the Chem-Dyne facility in accordance with the Consent Decree. Since the Consent Decree was first signed on September 23, 1985, bankrupt and defunct settling companies now represent approximately 11% of the settlors' original settlement of amount $17,453,605.

The longer the ground water system operates, the greater the expected frequency of costly repairs needed to keep the system running. During the span of this five year review, the total annual operating and administrative expenses increased from $514,151 in 2005 to $896,815 in 2009. Expenses in 2009 were greater than previous years due to the installation of new monitoring wells and extraction well IE-8, and the expansion of the SVE system. Operation and maintenance expenses in 2009 included replacement pumps for nine extraction wells due to fouling and mechanical failure (Table 5, 2009 Annual Report). According to an Ohio EPA interview of the Chem-Dyne plant operations manager, Mr. Ron Holt, each replacement pump costs $400 to $500. Additional system repairs in 2009 included the replacement of three extraction well flow transmitters, with a unit cost of $1,950

each. Also last year, the discharge pump to the Ford Hydraulic Canal required new seals, costing approximately $700. Power required to run the current remedial systems (pump and treat and soil vapor extraction combined) costs approximately $3,000 to $4,000 per month.

D. With pump and treat being primarily effective for maintaining hydraulic containment, and with SVE mass removal rates beginning to decline, an expedited attainment of ground water performance goals for MW-15 and additional wells is not anticipated (ground water flow velocities range from 0.5 to 1.5 feet/day, with time of travel from the northern SVE system to the power plant being on the range of one year). As of March 2009, eight of the site's 68 wells within the limits of the current plume were above the 100 ug/L total VOC performance goal. Among these, the most elevated well is consistently shallow monitoring well MW-15, located down-gradient of Chem-Dyne at the Hamilton Power Plant (Figure 4). As shown in Figure 5, total VOCs in MW-15 have been above the 100 ug/L performance goal since 1983. The concentration trend since 1991 appears to be constant.

E. No shallow monitoring wells are in place upgradient of MW-15 at an equivalent screen depth for accurate plume delineation. Shallow monitoring of the northern, on-site water table smear zone, at depths equivalent to MW-15 appears possible. Installation of northern Chem-Dyne site, intermediate depth wells MW-37 through 41 occurred during a seasonal water table low, in January 2009. During drilling, a lack of saturation to depths of 49 to 40 feet bgs respectively seemed to suggest that shallow monitoring wells screened above the observed zone of saturation would be dry. However, subsequent water level measurements were considerably shallower, ranging from 30.99 to 35.48 feet bgs.

Section line A-A' depicted in map view in Figure 4 and cross-sectional profile in Figure 6, three-dimensionally illustrates monitoring data gaps hampering meaningful interpretation of the northern plume. In each figure, the section line extends parallel to the northwesterly ground water flow path, extending from the Chem-Dyne site to the Hamilton Power Plant. The map view in Figure 4 depicts a 1980 aerial photographic base map, overlain by the spatial distribution of shallow wells (screen intervals from 30 to 50 feet bgs) shown in yellow and intermediate depth wells (screen intervals from 49 to 69 feet bgs) shown in red. As shown, no monitoring wells currently exist within the foot print of the former Chem-Dyne building or former tank farm immediately west to its west. With down-gradient monitoring well MW-15 consistently having the most elevated ground water concentrations above performance goals, the lack of upgradient monitoring for plume delineation poses a problem.

The cross-sectional view in Figure 6 superimposes total VOC concentrations from the most recent water table high sampling event of March 2010, with the corresponding screen intervals. As shown, the maximum total VOC concentration

of 3,509 ug/L occurs off-site at shallow monitoring well MW-15, screened from 28.5 to 38.5 feet below ground surface (bgs). Monitoring wells upgradient of MW-15 are not screened at an equivalent depth, but are screened deeper as follows: MW-37 (49 to 59'). MW-38 (40 to 50'); MW-41(50 to 60'); MW-39 (40 to 50'). If the source affecting MW-15 is located in the shallow zone beneath the former Chem-Dyne building or the former tank farm, ground water may migrate undetected, until reaching MW-15.

F. Institutional controls for ensuring long-term protectiveness, after completion of remedial actions, have not yet been implemented.

IX. Recommendations

A In order to expedite attainment of ground water performance goals established by the Consent Decree, the Agency recommends a phased approach for ground water plume delineation. First, we recommend vertical aquifer sampling during the spring water table high to further delineate the nature and extent of the northern and southern ground water plumes. As recommended, this phase would be followed by monitoring well design and installation. The purpose of new monitoring wells is to fill current plume delineation data gaps, and to measure improvements in ground water quality with time. The delineation of the northern plume is the highest priority, to address the intermediate depth extraction wells IE-1 and IE-8, and shallow monitoring well MW-15.

In order to address the monitoring gap upgradient of MW-15, shallow monitoring wells are recommended for the northwestern portion of the Chem-Dyne site, screened at elevations equivalent to MW-15. The resulting total VOCs and dominant compounds identified should be contoured in both map and cross-sectional profile, to identify source area currently prohibiting attainment of ground water performance goals.

B. Completion of the plume delineation phase will help identify the general location of source areas. The Agency then recommends that the horizontal and vertical extent of potential source areas be delineated through discrete interval soil and ground water sampling, to assist evaluation of in-situ remedial technologies for expediting attainment of ground water performance goals.

Current data indicates that the northwestern portion of the Site, in the vicinity of the former Chem-Dyne building, and the former tank farm immediately west are potential chlorinated hydrocarbon source areas affecting shallow monitoring well MW-15 and intermediate extraction wells IE-1 an IE-8. Figure 7 illustrates that the same compounds present in MW-15, are also present in upgradient, intermediate depth extraction well IE-8, located less than 100 feet south of the former Chem-Dyne building. The October 2007 residual source investigation revealed a similar

set of compounds in the northwestern site area, at vertical aquifer sample locations VP-1 and VP-2.

The Agency suggests that a localized dense non-aqueous phase liquid (DNAPL) source affecting MW-15 is not probable. In March 2010, the dominant chlorinated hydrocarbon at MW-15 was tetrachloroethene (PCE), with a concentration of 1,010 ug/L. Historic concentrations of tetrachloroethene at MW-15 are well below the 1% of solubility concentration generally regarded as indicative of a local DNAPL source (Dense Chlorinated Solvents and other DNAPLs in Groundwater, Pankow and Cherry, 1996). The solubility of tetrachlorethene is 200,000 ug/L (The Soil Chemistry of Hazardous Materials, second edition, J. Dragun, 1998).

The fact that MW-15 is a shallow well, screened from 28.5 to 38.5 feet bgs, suggests that an upgradient shallow source is present. The historic cyclical nature of VOC influent ground water concentrations to the air stripper, with maximum concentrations of PCE and TCE being coincident with a spring time water table high suggests the presence of a residual, shallow source or sources in the water table smear zone. Monitoring well data in Table 2 of the 2009 Annual report indicate that the smear zone, or water table fluctuation in the northern portion of the site was approximately 3 feet near monitoring wells MW-37, MW-38, MW-39, and MW-41, over 6 feet at extraction well IE-8, and approximately 9 feet at extraction well SE-10.

C. Finally, in order to ensure long-term protectiveness, the use of institutional controls should be evaluated. See institutional control recommendations under Section IV, Paragraph D of this five-year review report.

Table 5. Issues and Recommendations

Issue	Recommendation and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Yes/No)	
					Current	Future
Institutional Controls are not fully implemented at the Site.	An Institutional control work plan and draft IC Action plan should be prepared by the PRPs.	PRPs	U.S. EPA and Ohio EPA	March 2011	No	Yes

X. Protectiveness Statement

The site remedy currently protects human health and the environment because the excavation and removal of contaminated soils, the ground water monitoring and extraction system, and the site cap with impermeable infiltration barrier are functioning as designed and are protective of human health and the environment in the short-term. Once all ground water remedial action cleanup goals are achieved and the institutional controls fully implemented, the remedy should provide long-term protection.

XI. Next Review

The next five-year review for the Chem-Dyne site will be due September 2015, five years from the approval date of this review.

XII. Attached Figures

Figure 1. Site Location Map

2010 Well Network and 1980 Pre-Demolition Aerial Photograph

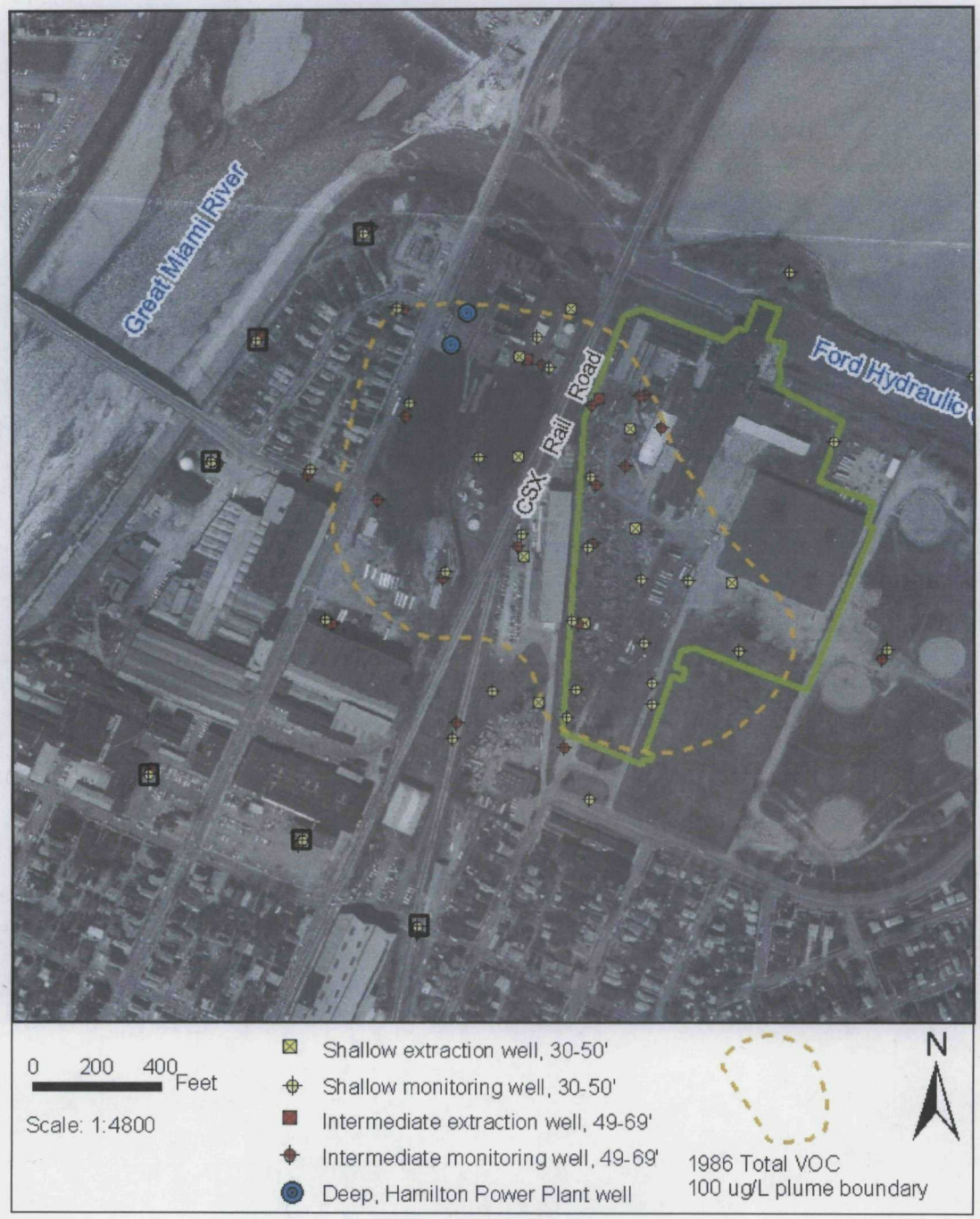

Figure 2: Pump and Treat and SVE Cumulative Mass Removal

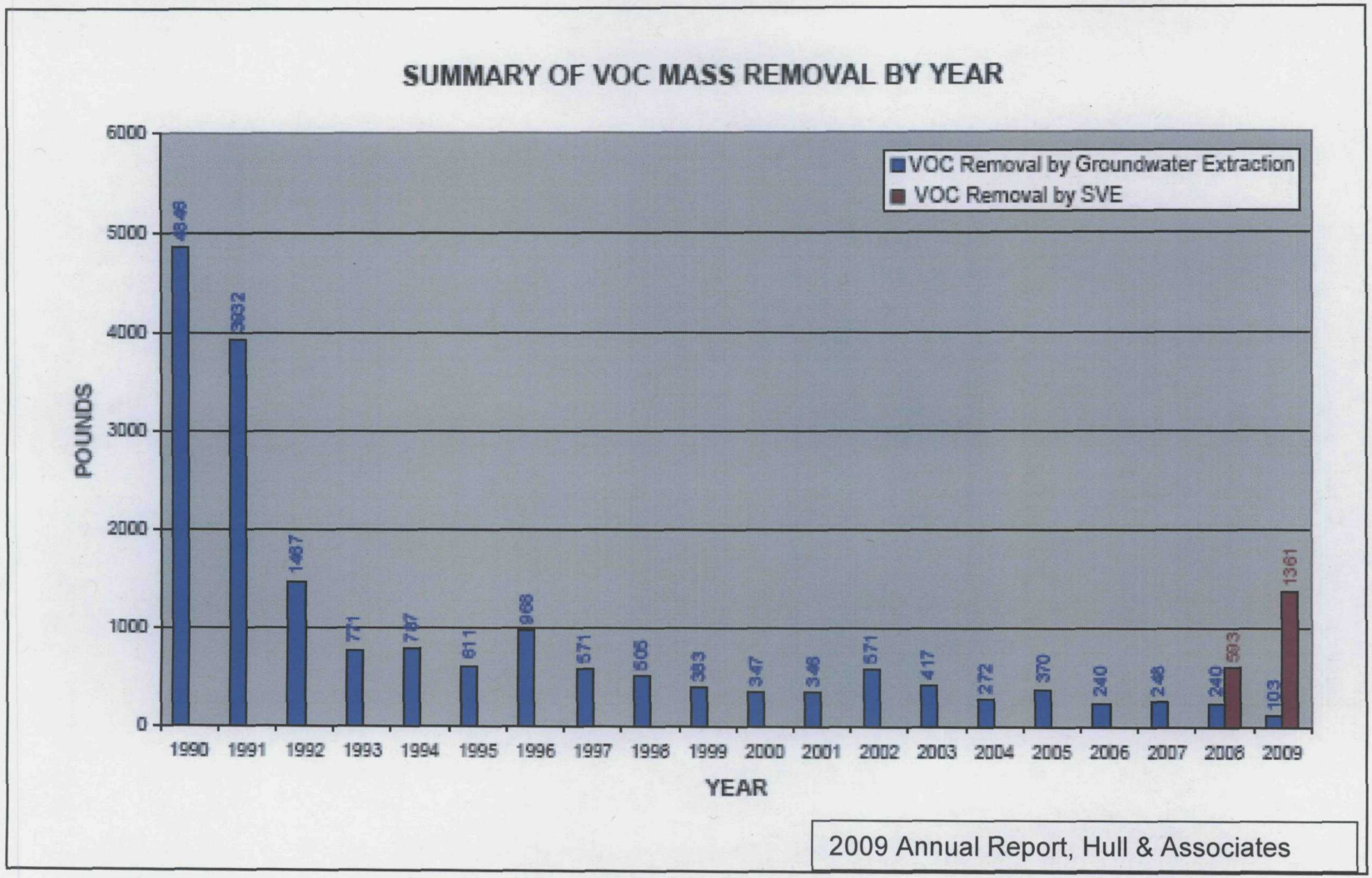

Figure 3. MWI-41 Core Near Former Chem-Dyne Building

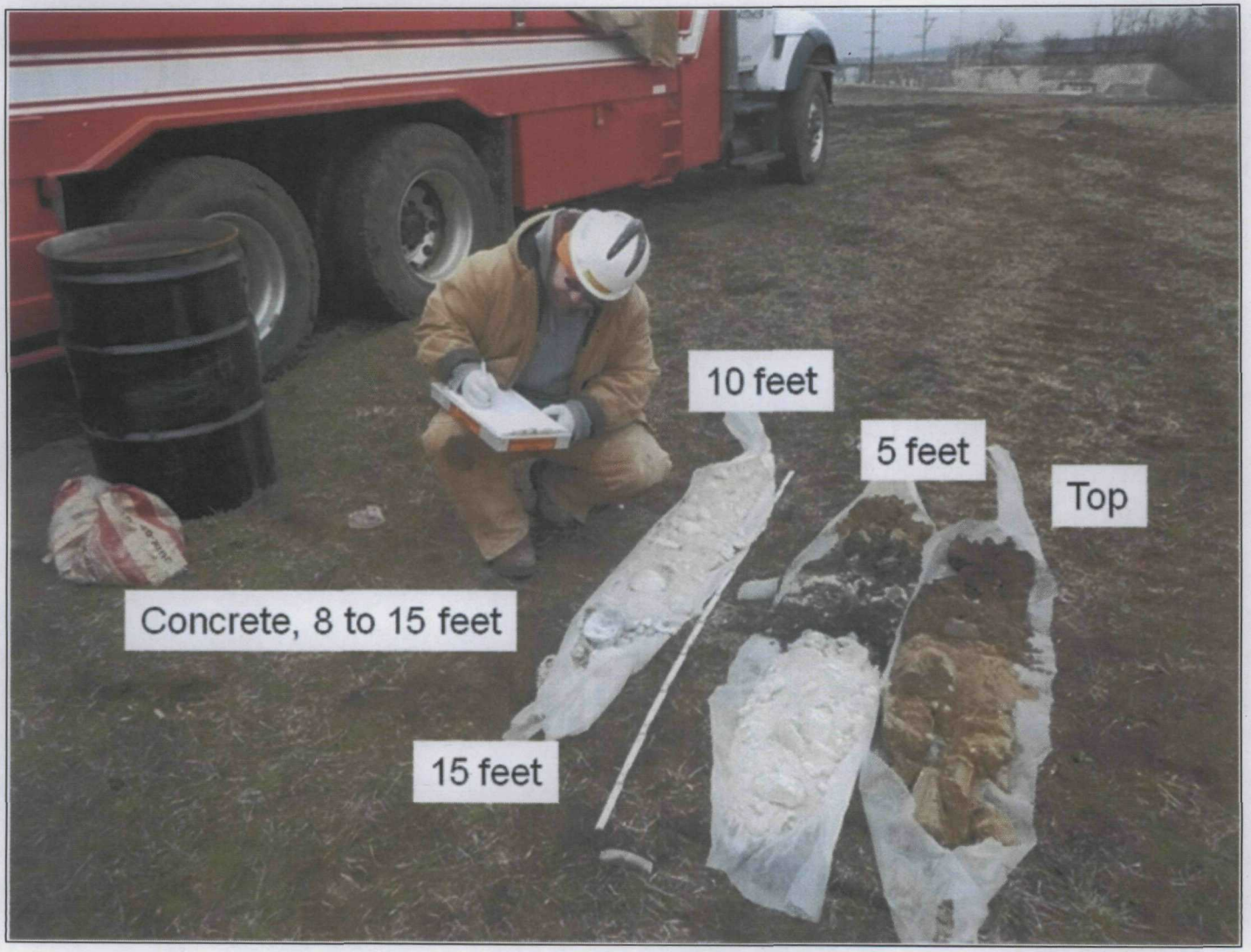

Figure 4. Section A-A', Map of Wells Along Flow Path Toward MW-15

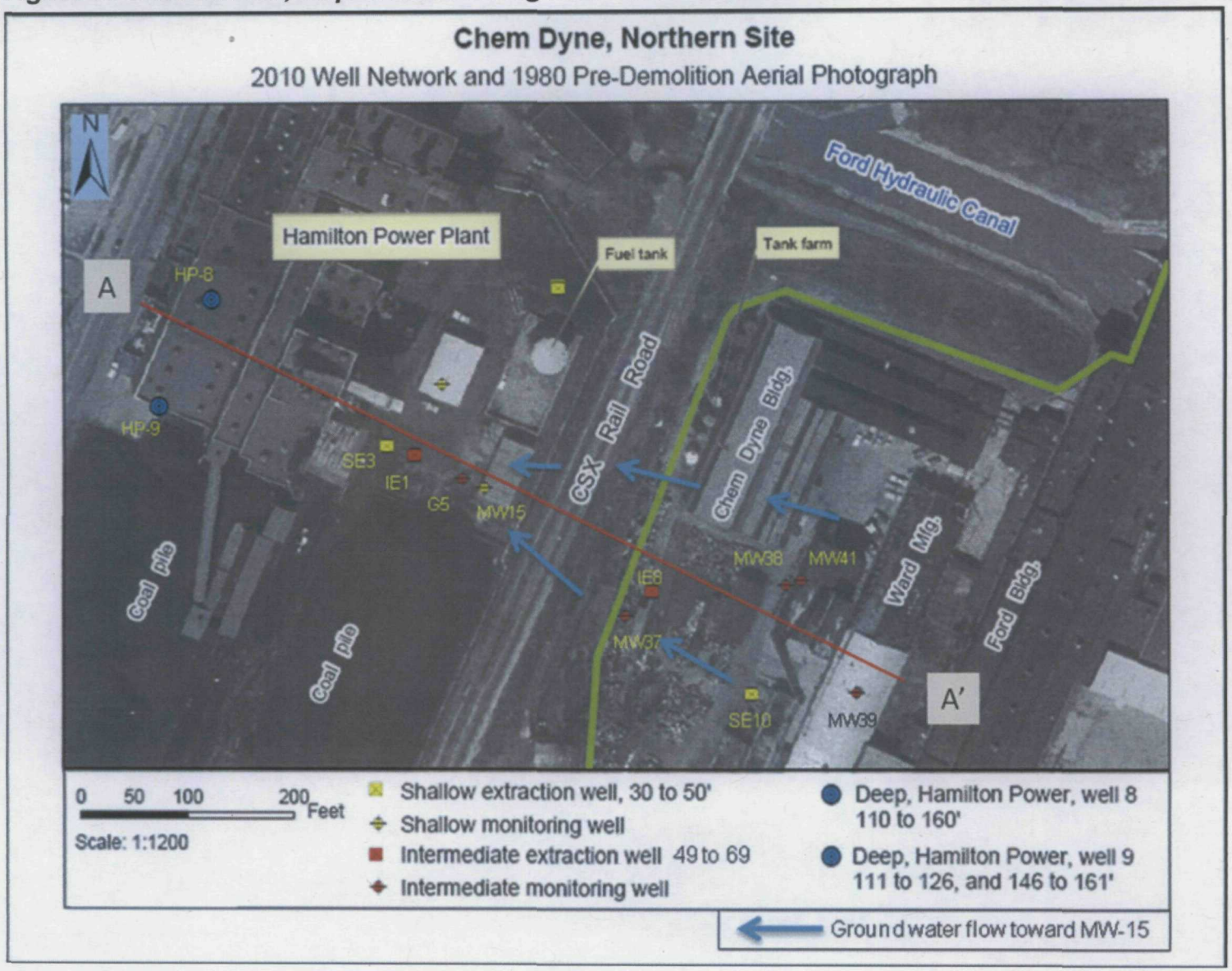

Figure 5: MW-15 Total VOC Concentrations with Time

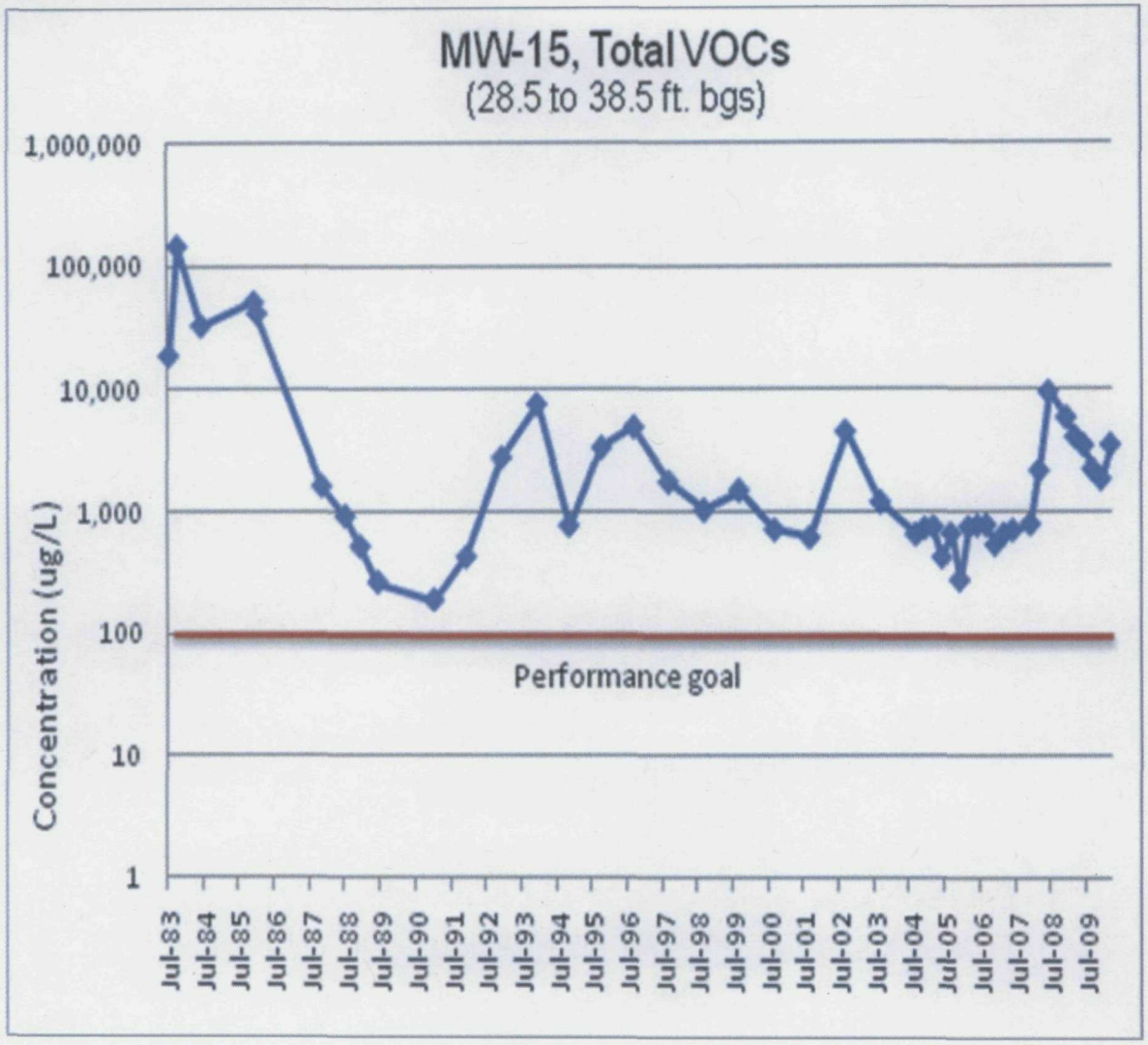

Figure 6: Section A-A' Total VOC Profile, Flow Path Toward MW-15, Spring 2010

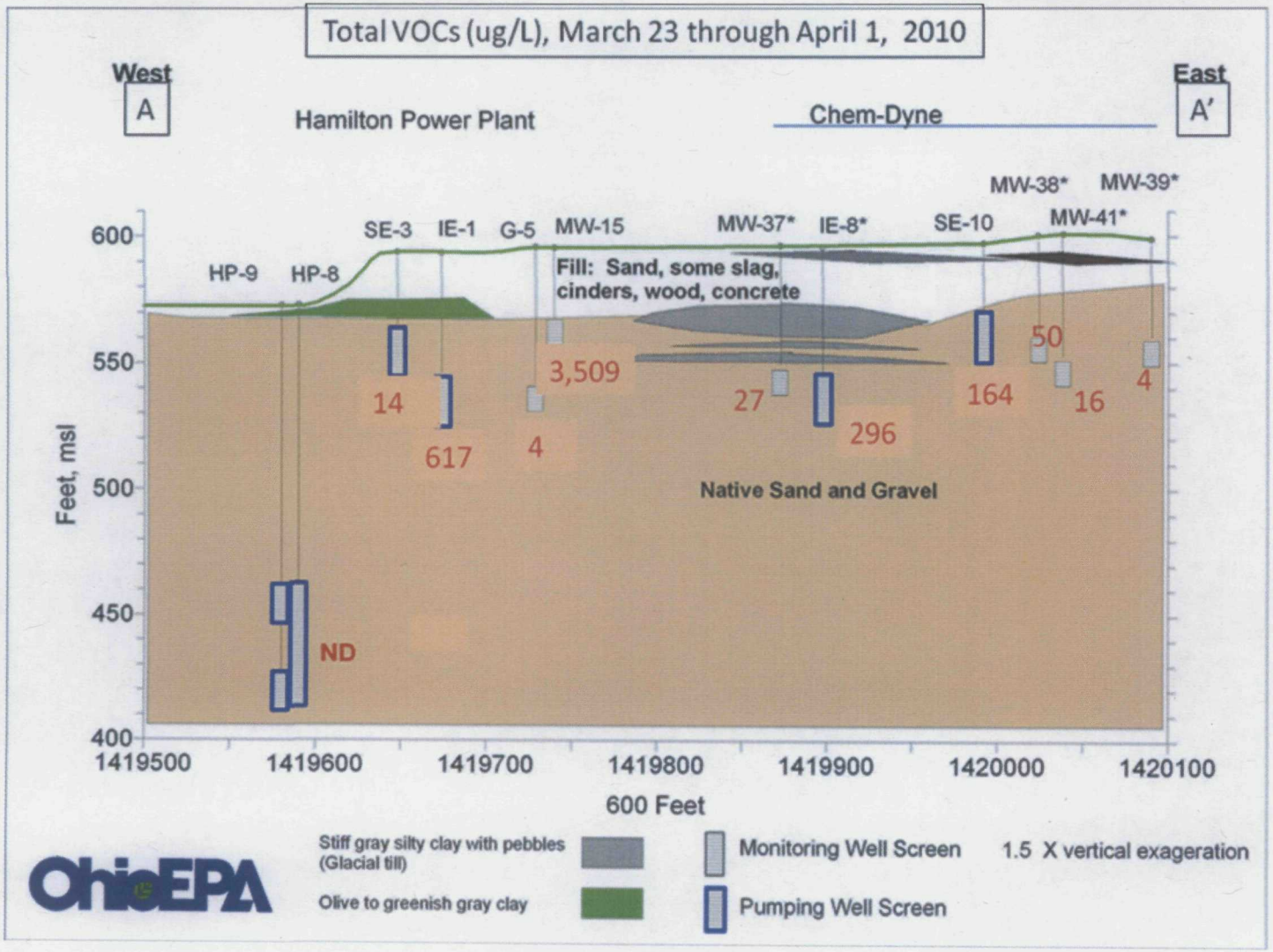

Figure 7. Section A-A' VOC Distribution, Flow Path Toward MW-15, Spring 2010

Northern flow path VOC results, March 23 through April 1, 2010										
ug/L	SE-3 March 23	IE-1 March 23	G5 March 23	MW-15 March 31	MW-37 March 31	IE-8 March 30	SE-10 March 29	MW-38 April 1	MW-41 April 1	MW-39 April 1
Total VOCs	14	617	4	3,509	27	296	164	50	16	4
1,2-dichloropropane				3.38		1.23				
1,1,2,2-tetrachloroethane	6.41	85.1		485		2				
1,1,2-trichlorethane	5.34	89.1		634	1.43	6.28				
1,2-dichloroethane		9.17		101		6.53				
1,1,1-trichloroethane				7.36		3.15				
1,1-dichloroethene	1.78	24		74.6		4.67				
1,1-dichloroethane	1.78	3.26		15.4		5.29				
Tetrachloroethene	10.9	84.8		1010	1.77	2.93				
Trichloroethene	6.88	68.6		522		6.61				
Cis-1,2-dichloroethene	29.4	189		491	22.6	94.6	4.62	51.8	46.9	4.31
1,1-dichloroethene	1.78	24		74.6		4.67				
Vinyl Chloride	6.81	31.9		55.1	1.31	37.8	1.21	8.06	14	
Chloroform		1.54		18.5		3.78				
Trans-1,2-dichloroethene		4.11		14.9		5.65				
Acrolein						82.7	152			
Chlorobenzene	2.02	19.4		47.6		11.2				
Benzene		2.61		11.1		6.77				
Ethyl Benzene						9.92	5.76			
Toluene						4.65				
1,4-dichlorobenzene		1.04		4.34						
1,3-dichlorobenzene		1.17		7.67						
1,2-dichlorobenzene		1.79		6.41						
	West A ← Ground Water Flow → East A'									